Interval training: alternating periods of high- and low-intensity exercise for maximum benefit - includes continuing education test

American Fitness, July-August, 1997 by Kathy Stevens

Over the past few years, there has been a regeneration of **interval training** techniques within the fitness industry. It involves the alternation of high and low-intensity cardiovascular exercise in specific timed ratios to improve the cardiovascular system. Think of it as adding peaks and valleys to a workout.

For years, athletes used **interval training** to enhance their physical conditioning and performance in competition. It's now popping up in group exercise and private **training** sessions as a prime way to increase exercise demands, utilize fat, break **training** plateaus and reduce steady state boredom.

What is the relevance of adding **interval training** to the program of the general fitness enthusiast or less fit individual? In the past, we were told harder isn't always better when it comes to choosing the right aerobic intensity. In the '80s, lower **training** zones were recommended. It was believed less intensity and longer duration would reduce certain exercise risks as well as burn a higher percentage of fat. It is a safe

exercise prescription, but we may need to take another look at the fat burning side of this issue.

We know the percentage of fat utilized during an activity may not be as relevant as the total calories burned by the end of the activity. For example, say a person runs for 30 minutes at 50% of his max VO [sub.2], burns 225 calories and utilizes 50% from fat stores or 112.5 fat 315 calories utilizing 40% from fat stores or 126 fat calories. Thus, not only would more total calories be burned by working at a higher intensity but more fat calories (regardless of the percentage drop) would also be utilized. The key is to complete the 30 minutes. If a person is unconditioned and cannot complete 30 minutes of activity at 70% max VO, it is better to lessen the intensity to make the full duration.

Many fit participants unnecessarily decrease their intensity. By including higher **interval** intensities for brief periods of time, a person can increase caloric outputs while decreasing the duration of the overall workout. Even the less fit participant can increase exercise intensity at a level that is within their **capacity** for brief bouts. For participants who don't have a lot of time to work out, this may be an efficient option.

It is well-documented that the body responds to **interval training** in a different way than it does to continuous **training**. This is not to say that one type of **training** is better or should be used instead of the other. Both can make important contributions to cardiovascular fitness.

Natural intervals occur when we encounter hills during a walk or run. If you play recreational sports, you probably experience the need for these bursts of intensity. If you have ever been late for a flight and had to rush through an airport while carrying luggage, you have probably felt the peaks and valleys of life's **interval** exercise demands. Today, **interval training** is successfully improving the fitness levels o a broader range of participants. If used properly, it can be an excellent way to maximize and increase the benefits of aerobic **training**. It can cut down on workout time, reduce more body fat than moderate **training**, and help regular exercisers stay motivated by new results.

Interval training increases aerobic **capacity**, or the ability to work harder and longer during cardiovascular activities. The ultimate goal of **interval training** is to push the aerobic and anaerobic systems to their maximum limits. It is important to understand the aerobic is what is used when doing continuous or steady state **training**. In this type of **training**, sufficient oxygen can be supplied to meet the demand of the working muscles so you can keep the activity going for extended periods of time; when you are working at these intensities, you are **training** aerobically. However, as exercise intensity is increased to the point that oxygen demands can no longer be met by the aerobic system, your anaerobic system

contributes to the energy requirements of the activity. This is only possible for a short period of time (from 30 to 90 seconds).

True **interval training** must include a work effort of high intensity followed by a recovery period of low intensity or complete rest. Both bouts combine to make up what is called an **interval** cycle. The high-intensity work effort should be performed above 85% of maximum ability (220 minus your age), while the low-intensity recovery period needs to bring your heart rate to below 60% max, or lower than typical continuous **training** levels. Continuous **training** refers to aerobic work you can comfortably perform for five minutes and longer.

An **interval** workout focuses exclusively on aerobic and anaerobic cardiovascular **training**. This should not be confused with circuit **training**, which involves a variety of exercise bouts that may include cardiovascular, strength **training** and flexibility work. **Interval training** ratios of work to recovery vary depending on the fitness level and conditioning goals. More recent programs have also included a broader range of intensity options in order to accommodate less fit participants. It is recommended that when entering a program that includes higher than previously performed intensities to check with a physician for medical clearance.

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PED 291 - Chapter 14 Notes

For success in endurance activities, you need a highly trained aerobic energy system.

You also need to train your anaerobic system for activities of short bursts (linemen in football), and stop/go activities (hockey, basketball).

Reviewing our 3 energy systems:

a. ATP/PC (creatine)

b. Lactic acid (glycotic) system

c. Aerobic system

During physical activity, these 3 will contribute to the total energy requirement depending on exercise duration and intensity.

Immediate energy transfer (a golf swing) occurs anaerobic ally, almost all energy from high energy phosphates ATP and PCr.

For activities lasting up to 90 minutes (a 400 meter dash) -it's still mostly anaerobic, but it comes from b. the lactic acid (glycolysis-the breakdown of carbohydrates) formation that provides the energy. How much lactate you can make and tolerate determines how much energy is generated. This system can be trained to work very efficiently.

As exercise duration goes between 2 and 4 minutes: the energy from the anaerobic system decreases, and it begins to come from oxygen consuming reactions.

After 4 minutes: almost all energy comes from aerobic systems (Lipolysis-the breakdown of fatty acids).

Know the chart on page 359: figure 14.2

Training principles

1. **Overload**- exercising at a level above normal so body changes occur that improve efficiency> How?

   a. the training frequency increases (times per week)

   b. intensity

c. duration (time doing activity)

2. **Specificity**- training specific muscles required for the specific activity (the SAID principle). Page 359 has an excellent example.

The training overload of specific muscle groups improves performance and aerobic power by improving oxygen transport and utilization in the trained muscles.

Factor to variation in training responses among individuals: THE PERSON'S FITNESS LEVEL AT THE START OF TRAINING. All performers on a team don't start at the same level of fitness, so they cant all work at the same intensity level. Training programs must meet individual needs and capabilities.

3. **Reversibility**- after only a week, reductions occur in physiologic function and exercise capacity. Athletes should maintain some level of off season sport specific exercises to slow down the rate of deconditioning.

When someone is a. running a 400 meter dash or b. working on blocking skills as a football lineman: here is how the energy is provided and how we can train that person.

1. At the start (the first 6 seconds), the ATP and PCr system provides energy. You can train this by: A. sets of sprinting all out for 6-10 seconds, with 30-60 seconds of rest in between. B. sled blocking for up to 10 second intervals with the same rest recovery.

2. Now the Lactic acid (anaerobic energy from the activation of glycotic (carbohydrate) energy pathways) system provides energy after the first 6 seconds, for the next minute of so.

Training this system:

a. bursts of up to 60 seconds of intense running.

b. Sled drills for up to 30 seconds.

•3-5 minutes of recovery between each one.

Every 60 second interval causes lactate stacking when blood lactate levels continue to increase with each interval of work until exhaustion sets in.

AEROBIC TRAINING

For those of us who don't work out (sedentary): cardiovascular fitness is measured by blood pressure, heart rate, cholesterol levels, and body composition.

An elite athlete's cardiovascular fitness is measured by oxygen intake and utilization.

Children's fitness levels are tested by the one mile run (table 14.2, page 363).

A low heart rate during a workout of moderate intensity means each beat is pumping enough blood with oxygen to the active muscles.

In labs they do step tests to determine fitness levels, and it's proven that how quickly your

heart beat returns to normal after the test (recovery heart rate) is a simple way to determine heart rate response to exercise stress.

Less than 20% of adults exercise regularly at sufficient intensity and duration levels to meet current guidelines of attaining fitness.

More than 60% of people who start programs don't maintain it.

2 goals of aerobic conditioning

1. improve the body's capacity to deliver oxygen

2. develop the muscles capacity to consume oxygen.

Factors that affect aerobic conditioning.

a. initial level of cardio respiratory fitness-improvement occurs if one's initial fitness is low. Someone in very good shape leaves little room of improvement. A 5% improvement for an elite athlete is more significant than a 25% increase for a sedentary person.

b. Frequency of training-3 times per week minimum.

c. Duration of training- 20-30 minutes each session. It can be a straight jog or 8-10 2 minute intervals of hard running.

d. Intensity of training-THE MOST CRITICAL FACTOR FOR SUCCESSFUL AEROBIC TRAINING because it reflects the activity's energy requirement for each minute, and the specific energy systems (remember we have 3) that are activated.

The most practical way to assess exercise intensity is by checking the exercise heart rate. For college age people to reach 130-140 beats per minute, or reach 70% of their maximum heart rate (220-age). This level of intensity represents the threshold stimulus (the minimum amount) to cardiovascular improvement. More intense exercise is more effective.

Conversational exercise- intense enough to stimulate a training effect yet not so strenuous that it limits a person ability to talk during the workout.

ADAPTATIONS TO EXERCISE TRAINING

Women and men show similar physiologic and metabolic adaptations to aerobic training.

A. Anaerobic system changes:

1. increased muscle levels of ATP/PCr (creatine) and glycogen storage.

2. increased number and activity of enzymes in fast muscle fibers that control the anaerobic phase (glycolysis) of glucose breakdown.

3. increased capacity to generate high blood lactate levels during maximum

exercise.

B. Aerobic system changes-enhances a muscle fiber's capacity to generate ATP

1. increase in mitochondria size and number, which improves it's capacity to generate ATP by oxidative phosphorylation (how ATP forms). Use page 103 and the example of a waterfall to review this process.

2. increase in aerobic system enzymes goes along with the increased mitochondria size and number. Now an athlete can have a high aerobic capacity during exercise without accumulating excess lactic acid.

3. more fatty acids are oxidized (burned). This process (Lipolysis) results from greater blood flow in the trained muscles and a higher quantity of fat metabolizing enzymes. Now the athlete can work at a higher level with less fatigue from the burning of carbohydrates (glycogen). Another reason why we need to eat some fat.

4. Carbohydrate metabolism is increased because the mitochondria has better oxidative capacity and the increased amount of glycogen storage in the liver and muscles.

5. muscle fibers aerobic capacity and lactate threshold levels increase. The muscle fibers grow in size.

Cardiovascular adaptations

1. Heart size- aerobic training enlarges the heart by increasing the size of the ventricles and thickness of the heart walls (eccentric hypertrophy) which improves stroke volume. If training reduces the heart will return to the size that it was before training.

(sammy strongheart/willie weakheart)

2. plasma volume- up to 20% higher which increases circulation and increases oxygen delivery during exercise.

3. stroke volume- in shape people have a larger stroke volume ability (more blood is pumped per beat) See figure 14.12, page 372.

4. heart rate- lower in trained people because of the heart's larger stroke volume ability. As exercise intensity increases, an athletes heart rate speeds up to a lesser extent than untrained people.

5. cardiac output- THE MOST SIGNIFICANT CHANGE IN CARDIOVASCULAR FUNCTION WITH AEROBIC TRAINING-an increase in cardiac output results directly from improved stroke volume.

6. oxygen extraction- during exercise more oxygen is extracted (taken) from artery blood during exercise.

7. blood flow- distribution of blood increases to muscles because of:

a. increase in cardiac output

b. lack of blood flow to non active areas

c. increased mitochondria size and number within the trained muscle

8. blood pressure- systolic

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diastolic

both of these go down: but the systolic drops more.

The average drop is about 6-10 points.

Lowering your blood pressure is the first line of defense against hypertension.

Pulmonary adaptations

a. maximal exercise-with training, improvements in maximal oxygen uptake leads to increased exercise ventilation. Why? YOUR AEROBIC CAPACITY IMPROVES.

b. submaximal exercise-20 weeks of run training increases ventilatory muscle endurance by 16%. There is less lactate accumulated, and a reduced feeling of breathlessness and pulmonary discomfort.

Less air needs to be taken in so breathing frequency decreases. Air remains in the lungs for longer time intervals between breaths. More oxygen is captured to be used by the muscles.

An untrained person breaths out 17% of air, the trained person 14%.

In hot weather trained people have a larger blood plasma volume and are better responsive to heat. Their bodies also cool more efficiently.

Specificity factor-if you are doing an activity you don't do very often, your muscles don't use the air as efficiently.

Starting a program page 376

2 methods of training with exercise intensity for aerobic training:

1. training at a percentage of air taken in and used.

2. training at a percentage of your maximum heart rate. (220 -age: then take pulse during exercise)

While running it might be at 140: that is 70% of your maximum (this is recommended for

a 20-30 minute time period), or you can do an activity at 120 for 45 minutes.

MORE IS NOT USUALLY BETTER

The rating of physical effort corresponds with exercise heart rate. All of us can learn to exercise at a specific level based on your feelings of exertion (listen to your body).

Continuous versus intermittent training

Long slow distance requires sustained steady rate aerobic exercise: great for people starting out.

Long slow distance can (without knowing) progress at a comfortable threshold level of 70% max heart rate and maybe higher. This activates mostly slow twitch fibers.

Elite distance runners will run for 45 minutes steady and then do 30-40 minutes of sprint intervals (intense activity with periods of low energy expenditure in between: this is like a lot of sport activities). The spacing of exercise and rest are important to training: to figure this out you can use your recovery heart rate as an indicator to determine if you need more rest. Interval training can be short (50 meters) or long (mile repeats).

I'm going to train for running a four minute mile in an 11 minute work period, by running at a four minute mile pace for 15 seconds and then resting for 30 seconds until I reach a mile (actually it takes 11 min. and 30 sec.).

The ideal aerobic workout-page 380

Relief interval training: for sprinters it's 1:3. Sprint 10 seconds, rest 30. For activities of 60-90 second work: rest is 90-120 seconds (1:1.5)

Maintaining fitness: if intensity is the same, training frequency and duration can decrease as much as two thirds. For example: 6 day a week training reduced to 2, and 40 minutes per day reduced to 13.

But, even a third reduction in intensity will decrease oxygen uptake dramatically, even if you are working out 6 days a week for 40 minutes. EXERCISE INTENSITY IS THE PRIMARY FACTOR TO IMPROVING AEROBIC CAPACITY WITH TRAINING.

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PED 291 - Physiology of Exercise

Course Syllabus Spring 2002

Credit Hours: 3

Text(s): Essentials of Exercise Physiology, 2nd ed., McArdle, Katch, and Katch. Student Study Guide to Essen Exercise Physiology

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Office Hours: Hervert:
Lee: M, 2-3; TR, 1-2.

The doors to our virtual offices are always open.
Email: klee@uwc.edu
Course Web page: http://blackboard2.imt.uwm.edu

COURSE OBJECTIVE

The primary emphasis of this course is to present an overview of normal human physiological function and how altered and restored in response to exercise and training. Students will learn to assist individuals in the develop healthy, active lifestyle in which the benefits of physical activity are understood, valued, and integrated into dail

ATTENDANCE POLICY AND DEFINED EXCUSES

Attendance is expected and will be recorded. Provision can be made for occasional conflicts (e.g., participation university sponsored events), but students are requested to bring such activities to the attention of the instructc ADVANCE and as soon as possible. In case of illness or other unavoidable reason for missing class, it is the re of the student to contact the instructor within 24 hours and be able to document the reason for being absent. W allow a student to make-up an exam because of forgetfulness, colds, headaches, hangovers, etc. Only one ma exam will be given to a student during the semester. Medical excuses need not have the specific condition ider reasons of privacy. Absences will not be used to compute grades unless mandated by campus or system admi However, attendance records will be reviewed prior to student counseling, submission of D/F midterm grades, i for withdrawal or incompletes, and assignment of final grades. It is the responsibility of the student to find out w announcements were made, to obtain lecture notes, handouts, etc., if a class is missed.

NO EXTRA CREDIT assignments will be given.

MAKE-UP EXAMS AND QUIZZES will only be scheduled upon presentation of verifiable documentation for an absence (university-sponsored event, severe illness, death in family). It is the student's responsibility to report t

absence to the instructor within 24 hours. No student will be allowed more than one makeup exam/quiz per ser
Again, verifiable documentation must be provided within 24 hours. We will not allow a student to make-up an e:
because of forgetfulness, colds, headaches, hangovers, etc.

Special Needs Statement

We at UW-Waukesha are here to help all students succeed. All reasonable arrangements will be made to acco
student's special needs in order to successfully complete this course. Students who take their exams through D
to make arrangements with Judith Becker (521-5210) as early in the semester as possible and to remind me be

Religious Beliefs Accommodation

Board of Regents policy states that students' sincerely held religious beliefs shall be reasonably accommodate
respect to scheduling all examinations and other academic requirements. Students must notify the instructor, w
first three weeks of the beginning of classes of the specific days or dates on which they will request accommod
an examination or academic requirement.

Academic Misconduct

The University believes that academic honesty and integrity are fundamental to the mission of higher educatior
University of Wisconsin System. The University has a responsibility to promote academic honesty and integrity
develop procedures to deal effectively with instances of academic dishonesty. Students are responsible for the
completion and representation of their work, for the appropriate citation of sources, and for respect of others' ac
endeavors. Students who violate these standards are subject to disciplinary action.
UWS 14 defines academic misconduct as any "action which a student: 1) seeks to claim credit for the work or e
another without authorization or citation; 2) uses unauthorized materials or fabricated data in any academic exe
forges or falsifies academic documents or records; 4) intentionally impedes or damages the academic work of
engages in conduct aimed at making false representation of a student's academic performance; 6) assists othe
in any of these acts." UWS 14 allows for disciplinary sanctions that range from an oral reprimand to suspensior
expulsion from the University. A copy of the full academic misconduct policy is available through the Student S
office.

Wk of/Day	Topics	Assignment
T, 1/22	Intro to course; Central and Peripheral NS	Chapter 12
R, 1,24	The Neuromuscular System and Exercise	Chapter 12
T, 1/29	The Neuromuscular System and Exercise	Chapter 12
R, 1/31	QUIZ 1; Neuromuscular /Cardiovascular System	Chapter 12; Chapter 1
T, 2/5	The Cardiovascular System and Exercise	Chapter 11
R, 2/7	QUIZ 2; Cardiovascular/Pulmonary System	Chapter 11; Chapter 1
T, 2/12	The Pulmonary System and Exercise	Chapter 10
R, 2/14	QUIZ 3; The Pulmonary System and Exercise	Chapter 10
T, 2/19	Hormones, Exercise, and Training	Chapter 13
R, 2/21	Exam 1	

T, 2/26	Macronutrients	Chapter 2
R, 2/28	Macronutrients	Chapter 2
T, 3/5	QUIZ 4: Macronutrients/micronutrients	Chapter 3
R, 3/7	Micronutrients and water	Chapter 3
T, 3/12	QUIZ 5: Micronutrients/water/energy transfer	Chapter 4
R, 3/14	Fundamentals of human energy transfer	Chapter 4
T, 3/19	QUIZ 6: Human energy transfer during exercise	Chapter 5
R, 3/21	Energy transfer during exercise/QUIZ 7	Chapter 5
T, 3/26	Spring Break, no classes Spring Break, no classes	
R, 3/28	Spring Break, no classes Spring Break, no classes	
T, 4/2	Energy expenditure at rest and during exercise	Chapter 7
R, 4/4	Optimum nutrition for exercise and sport	Chapter 9
T, 4/9	Optimum nutrition for exercise and sport	Chapter 9
R, 4/11	Exam 2	
T, 4/16	Training anaerobic/aerobic energy systems	Chapter 14
R, 4/18	Training anaerobic/aerobic energy systems	Chapter 14
T, 4/23	QUIZ 8 chapter 14/ training muscles	Chapter 15
R, 4/25	Training muscles to become stronger	Chapter 15
T, 4/30	QUIZ 9: chapter 15/ Environment & Exercise	Chapter 16
R, 5/2	Environment & Exercise/ QUIZ 10	Chapter 16
T, 5/7	Ergogenic aids and exercise	Chapter 17
R, 5/9	Ergogenic aids and exercise	Chapter 17

Final Exam: Wednesday, May 15: 8-10AM
This tentative schedule is subject to change.

Important Dates

- 2/4, Monday. Last day to register pass/fail. Last day to receive 100% refund.
- 2/18, Monday. Last day to receive 50% refund
- 3/25-29, Spring Recess, no classes
- 4/8, Monday. Last day to drop.
- 5/10, Friday. Last day of classes.

- 5/15, Wednesday, 8-10AM Final Exam

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